Characterization of a Ho:Tm:Cr:YAG Laser With a Cr:GSAG Laser as Pumping Source

by

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Rare earth lasers have been in existance since the first laser was developed. The primary lasing elements for the class of lasers in the infrared has been neodymium and chromium. However, the need for eye safe lasers in the mid infrared range has prompted an enomous amount of research to the use of other elements. Holmium has been investigated extensively as the source of infrared radiation for atmospheric research as well as medical research.

The holmium transistion $^5I_7$ to $^5I_8$ transition produces a photon of wavelength 2.1 μ which is in the desired region for use in the above applications. Most holmium research has been done at liquid nitrogen temperatures using flashlights and low power diodes laser as pumping sources.

In order to obtain lasing at room temperature with holmium, thulium has to serve as an intermediary. The pumping source of around 785 nm pumps thulium to the $^3H_4$ it subsequently decays to the $^3F_4$ of thulium and simultaneously excites a photon from the ground state of thulium by a cross relaxation process the two photons then populate the holmium $^5I_7$ state and lasing occurs in the transition to the $^5I_8$ state. The wavelength of the laser beam is 2.1 microns.

In was was desired to similate the pumping effect of a high power diode laser in order to produce a holmium 2.1 micron laser with relatively high power. At room temperatures previous researchers have been able to obtain power only in the milliwatt region. The Cr:GSAG laser was constructed and used because its wavelength is in the region of 785 nm and its power output is sufficiently high for the investigation. The Cr:GSAG laser has been profiled and found to be ideal for this investigation. Preliminary experiments on the holmium laser crystal, consisting of .36 atomic percent of holmium, .85 atomic percent of chromium and 5.9 atomic percent of thulium in a yttrium aluminum garnet has revealed promising information.

The results of the experiments performed indicates that high power can be obtained from a holmium laser in the 2.1 micron region. Powers in the neighborhood of 10 or more watts have been obtained from the holmium crystal. This represents several orders of magnitude of the power obtained by other researchers. Work is continuing on the complete characterization of the laser. A Q-switched experiment is planned.